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(54) A PROCESS FOR PREPARING HALOGEN-FREE, DEPOSIT-CONTROL FUEL ADDITIVES COMPRISING A HYDROXYPOLYALKENE AMINE

HERSTELLUNGSVERFAHREN FÜR HALOGENFREIE HYDROXYPOLYALKENHALTIGE
ABLAGERUNGSSTEURENDE BRENNSTOFFZUSÄTZE

PROCEDE POUR LA PRODUCTION D'ADDITIFS ANTICALAMINE SANS HALOGENE POUR
CARBURANT, RENFERMANT UNE AMINE D'HYDROXYPOLYALCENE

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EP-A- 0 384 086	EP-A- 0 385 039
EP-A- 0 476 485	WO-A-92/12221
US-A- 2 856 363	US-A- 3 793 203
US-A- 3 794 586	US-A- 3 898 056
US-A- 4 018 613	US-A- 4 055 402
US-A- 4 123 232	US-A- 4 302 215
US-A- 4 353 711	US-A- 4 410 335
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US-A- 4 943 381	

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14.02.1992 US 835541

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EP 0 573 578 B1

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Description**Field of the Invention**

5 The invention relates generally to a process for preparing a halogen-free hydroxypolyalkene amine composition comprising more particularly a hydroxy-polyalkene amine, such as hydroxypolybutene amine and hydroxypolypropylene amine, by reacting an epoxidized polybutene having a number average molecular weight of from 400 to 2200 or an epoxidized polypropylene having a number average molecular weight of from 170 to 2200 at an elevated temperature with at least one type of an amine compound being a primary or secondary monoamine, a primary or secondary diamine, 10 or a primary or secondary polyamine. The halogen-free hydroxypolyalkene amine composition obtained in the above process can be used as a deposit-control fuel additive.

Background of the invention

15 Deposit-control fuel additives effectively control deposits in engine intake systems (carburetors, valves, fuel injectors, etc.). A major deposit-control fuel additive used in gasoline today is made by the chlorination of polybutene to produce an intermediate followed by the reaction of this intermediate with an amine compound to produce a polybutene amine. These polybutene amines typically contain from 0.5 to 1.0 percent residual chlorine, and seldom less than 0.25 percent chlorine. With today's concerns regarding halogen compounds, however, it is desirable to reduce or eliminate 20 chlorine from fuel additives.

US-A-4 302 215 relates to hydrocarbyl carbonates and their fuel compositions which are deposit-control additives in gasoline compositions.

US-A-3 794 586 relates to a lubricating oil composition containing a hydroxyalkyl-substituted polyolefin prepared by reacting a polyalkene epoxide with a polyamine at a temperature of from 15 to 180°C.

25 EP-A-384 086 relates to a process for producing long chain alkyl amines from polyolefins by reacting (a) a polyolefin having a molecular weight in the range of 330-2000 with ozone in the presence of a solvent, (b) reacting the ozonolysis product from (a) without separation and/or isolation of the carbonyl compounds formed therein with a primary hydrocarbyl amine to form an imine, (c) hydrogenating the imine from step (b) to give an amine in the presence of a hydrogenation catalyst, and (d) recovering the long chain alkyl amine from the hydrogenation products formed in step (c).

30 EP-A-385 039 relates to a process for producing active carbonyl compounds predominating in aldehyde groups from polybutene having at least 50 percent of the unsaturation in the terminal position. The process comprises an initial epoxidation of the polybutene followed by isomerization of the epoxide so formed at a relatively higher temperature. The active nature of the carbonyl group enables these compounds to be converted to the corresponding amines or imines which can be used as fuel and lube oil additives.

35 Further deposit-control fuel additives which are also free from halogen are described in WO-A-92 12 221 and EP-A-0 476 485. The former document discloses fuel compositions containing hydroxyalkyl-substituted amines as deposit-control additives which are formed by reacting a branched chain polyolefin epoxide having a molecular weight of between 400 and 5000 with ammonia or an amine, the polyolefin being preferably a polybutene or a polypropylene. The reaction between the amine and the epoxide is carried out at a temperature between 100 and 250°C in an open or 40 closed vessel. The latter document discloses polyisobutyl-amino-alcohols and their use as deposit control agents in fuels. They are prepared by reacting an epoxidized polyisobutene with diethylene triamine by refluxing the two reagents in xylene at about 140°C, i.e. they are also produced in an open vessel under atmospheric conditions.

Summary of the Invention

45 The object of the present invention is to provide further processes for the preparation of halogen-free hydroxypolyalkene amine fuel additives.

The above object can be achieved according to the present invention by a process for preparing a halogen-free hydroxypolyalkene amine composition as defined below.

50 Subject-matter of the present invention is a process for preparing a halogen-free hydroxypolyalkene amine composition by first reacting a polybutene having an average molecular weight of from 400 to 2200 or a polypropylene having a number average molecular weight of from 170 to 2200 with hydrogen peroxide in the presence of an organic carboxylic acid and an acid catalyst and then reacting the obtained epoxidized polybutene or epoxidized polypropylene at a temperature of from 185 to 300°C in a closed vessel at a pressure of up to about 2.1 MPa (300 psi) with an excess of from 2 to 20 moles per mole of said epoxidized polybutene or epoxidized polypropylene of at least one type of an amine compound being a primary or secondary monoamine, a primary or secondary diamine or a primary or secondary polyamine.

55 The hydroxypolyalkene amines, such as hydroxypolybutene amines and hydroxypolypropylene amines, obtained

according to the above process, are very useful as halogen-free deposit-control fuel additives.

According to a preferred embodiment of the present invention the molecular weight of the polybutene used in the process of the present invention is from 700 to 1600 and the molecular weight of the used polypropylene is from 290 to 1900.

5 According to the present invention the reaction is preferably carried out at a temperature of from 230° to 285°C.

The preferred amine compound used in the process of the present invention is dimethylaminopropylamine, diethylenetriamine or ethylenediamine, or combinations thereof.

According to a further preferred embodiment of the present invention in the claimed process at least 15 percent of said epoxidized polyalkene are converted.

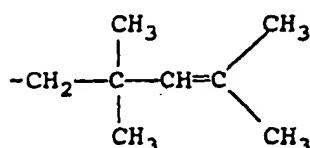
10 The structure of the hydroxypolyalkene amines prepared according to the process of the present invention is generally a function of the end group structure of the polyalkene and generally several such structures exist for each polyalkene compound. The following are examples of some of the end group structures in polybutene and hydroxybutene amines generally derived therefrom.

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Polybutene:

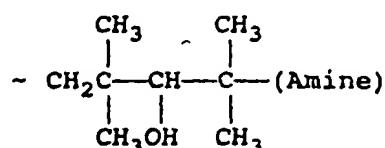
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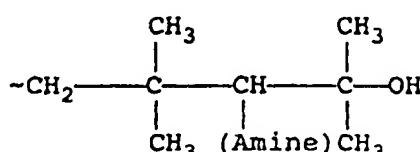
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Hydroxypolybutene
Amines



or

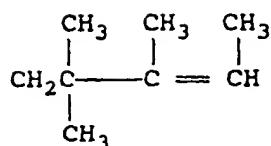
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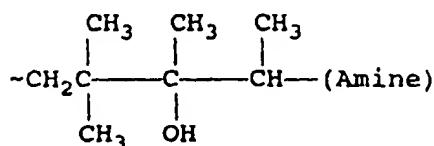
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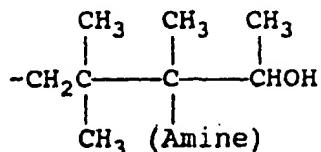


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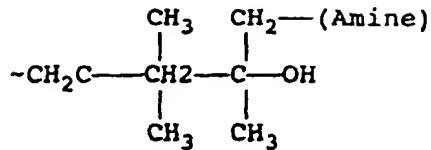
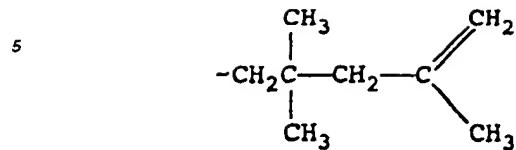
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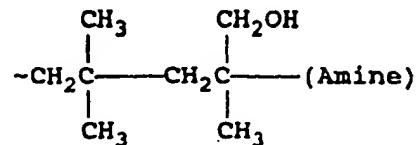
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or

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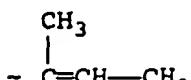
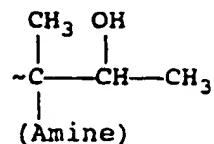
20 The following examples are some of the end-group structures of polypropylenes and the hydroxypolypropylene amines generally derived therefrom.

POLYPROPYLENE

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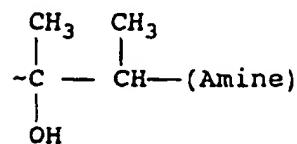
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HYDROXYPOLYPROPYLENE AMINES

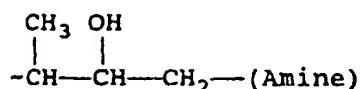
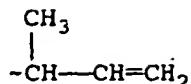
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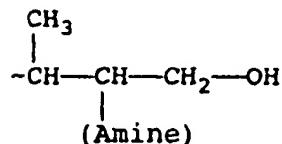
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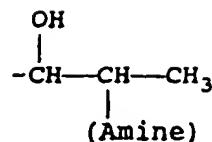
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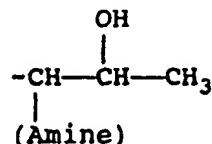
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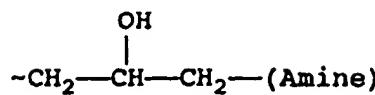
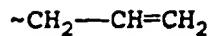
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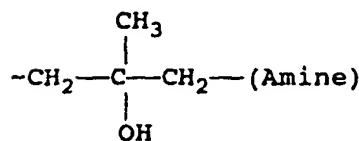
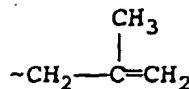


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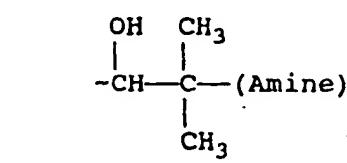
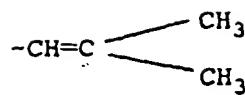
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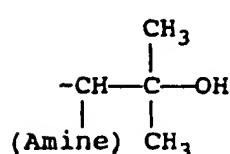
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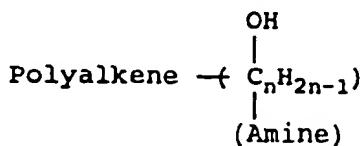
Cationically polymerized polypropylene suitable for use in this invention contains several different end-group structures resulting from extensive rearrangement during manufacturing. These end-group structures are represented as

3 or 4 carbon atom-terminated polypropylenes in the preceding structures. When 4 carbon atom-terminated structures are involved, such is due to alkyl group migration from one of the preceding repeat units.

A generic representation of the hydroxypolyalkene amine is:

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where $n = 3$ or 4 , where Polyalkene is polypropylene or polybutene, and where, as apparent from the above formulations, the hydroxyl group and the amine group are always attached to adjacent, i.e., an adjoining or contiguous carbon atom.

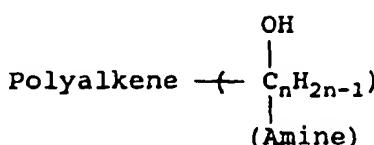
15 The hydroxypolyalkene amines of the present invention are produced by a multiple-step process in which a polyalkene is first epoxidized in a suitable solvent using hydrogen peroxide in the presence of an organic acid. The intermediate epoxide is subsequently treated with a primary or secondary amine compound which may be a monoamine, a diamine, or a polyamine causing addition of the amine compound to the polyalkene epoxide intermediate. This addition reaction is run either neat or in a suitable solvent with an excess of amine at a temperature of from 185°C to 300°C .
20 The excess amine and solvent, if present, are removed from the final hydroxypolyalkene amine product by any conventional procedure such as vacuum stripping, wiped film evaporation, or a combination of vacuum stripping and water washing.

DETAILED DESCRIPTION OF THE INVENTION

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In accordance with the present invention, a process for making a halogen-free hydroxypolyalkene amine product generally of the following formula is provided

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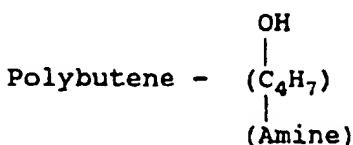
where $n = 3$ or 4 , where Polyalkene is cationically polymerized polypropylene or polybutene, and where the hydroxyl group and the amine group are attached to adjacent carbon atoms. That is, the amine group is attached to one carbon atom which is connected to the next or contiguous carbon atom which has the hydroxyl group thereon. Due to the large number of possible isomers, a single generic formula with amine on one carbon atom and the hydroxyl group on the next carbon atom cannot be drawn, rather specific examples have been set forth hereinabove and below.

40 The amine substitution is fully described hereinbelow in a multiple-step process comprising an epoxidation step, followed by the addition of an amine compound to the intermediate epoxide thus produced. In the first step, a polyalkene is epoxidized. The polyalkene can be any polyalkene known to the art and to the literature with the initial alkene monomer containing 3 or 4 carbon atoms, with 4 carbon atoms being highly preferred.

45 Polybutene is the commercial name for polymers manufactured from C_4 olefin refinery streams of catalytic or steam-cracked petroleum. These C_4 fractions consist mainly of isobutylene, but also contain other C_4 olefins. The definition of polybutene is well known to those skilled in the art, and is described in "Carbocationic Polymerization" by J.P. Kennedy and E. Marechal, Wiley-Interscience, New York, NY, 1982, pp. 469-475. When the halogen-free hydroxypolyalkene amine product is made from a polybutene, the end product has the general formula

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Specific examples of various isomers of such products is set forth hereinabove.

5 Polypropylene is the commercial name for polymers manufactured from C₃ olefin refinery streams of catalytic or steam-cracked petroleum. In the manufacture of polypropylene utilizing cationic polymerization, there is opportunity for carbon atom rearrangement. Thus, a generic formula cannot be set forth inasmuch as the polypropylene end group structure will contain one unsaturated point within the three or four terminal carbon atoms as set forth above in the various formulas. The definition of polypropylene, as well as the end group structures thereof which are predominantly branched, are set forth and described in "J. Org. Chem. 49, *1. Puskas and S. Meyers, 258 (1984), and "Macromolecules, 12* 1. Puskas, E. M. Banas, A. G. Nerheim, and G. J. Ray, 1024 (1979).

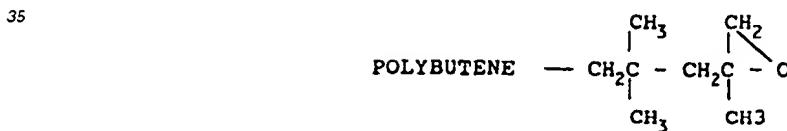
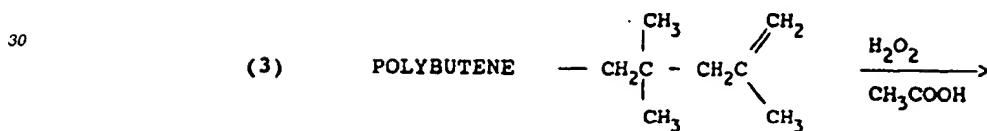
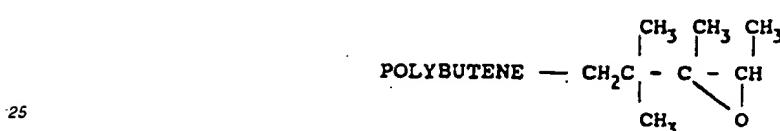
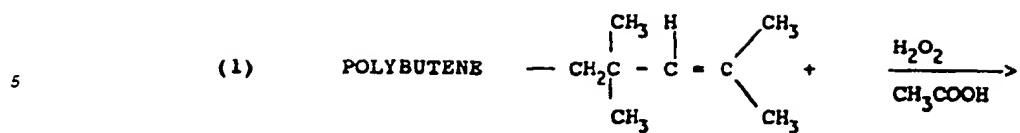
10 The initial step of the preparation of the compositions of the present invention is the epoxidation of a polyalkene. When the polyalkene is polybutene, it has a number average molecular weight of from 400 or 450 to 2,200, preferably from 700 to 1,600, and most preferably from 800 to 1,400, and a degree of polymerization of from 7 or 8 to 40, desirably from 12 to 29 and preferably from 14 to 25. When the polyalkene is polypropylene, it has a number average molecular weight of from 170 to 2200, and preferably from 260 to 1290, and a degree of polymerization of from 4 to 40, and desirably from 6 to 30. More generally, are the number average molecular weight of the polypropylene is desirably from 290 or 330 to 1900 or 2200, more desirably from 460 to 1720, and preferably from 630 to 1290, that is a degree of polymerization of from 7 or 8 to 40 or 52, desirably from 11 to 40, and preferably from 15 to 30.

15 The epoxidation reaction occurs by reacting polyalkene with hydrogen peroxide as well as an organic carboxylic acid in the presence of an acid catalyst. The organic carboxylic acid reacts with the hydrogen peroxide to form an intermediate peroxy acid which reacts with the polyalkene and subsequently forms an epoxidized polyalkene with regeneration of the organic carboxylic acid. Due to the high viscosity of the starting polyalkenes, the epoxidation reaction is desirably carried out in a hydrocarbon solvent. The amount of the hydrogen peroxide is generally from 0.5 to 2.5, and preferably from 1.5 to 2.0 moles per mole of polyalkene based upon the number average molecular weight of the polyalkene. The organic carboxylic acid is generally a monocarboxylic acid having a total of from 1 to 4 carbon atoms with acetic acid being preferred. The amount of the organic carboxylic acid is generally from 0.15 to 0.5 moles, and preferably from 0.25 to 0.40 moles per mole of polyalkene based upon the number average molecular weight of the polyalkene. In addition to this organic carboxylic acid, an acid catalyst is also required. The acid catalyst can be one or more organic acids, or one or more inorganic acids, or combinations thereof which are utilized to effect the epoxide reaction. Such a reaction is described in Organic Peroxides, Vol. 1, Wiley-InterScience, New York, 1970, Daniel Swern, at pgs. 340-369. Examples of specific acid catalysts include methanesulfonic acid, toluenesulfonic acid, sulfuric acid, and phosphoric acid, and are utilized in small amounts as from 0.0025 to 0.030 moles per mole of polyalkene based upon the number average molecular weight thereof.

20 The hydrocarbon solvent utilized in the polyalkene epoxidation reaction can generally be any inert organic solvent, that is a solvent which does not enter into reaction with any of the reactants. Such solvents include aromatic solvents having a total of from 6 to 9 carbon atoms with specific examples including xylene, toluene, and C₉ aromatic, an aliphatic solvent having from 6 to 10 carbon atoms with specific examples including isooctane, heptane, and cyclohexane, or various aliphatic substituted aromatic compounds, as well as combinations thereof.

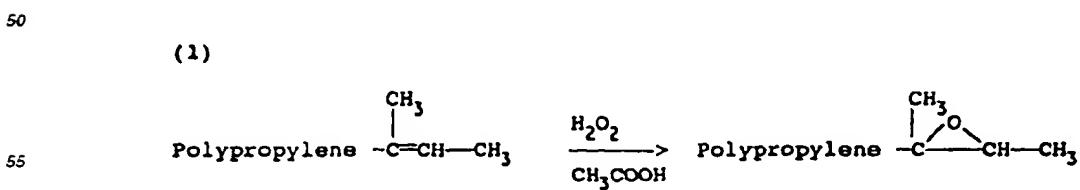
25 The temperature of the epoxidation reaction will depend on the organic acid used and is a function of the stability of the intermediate peracid and the reaction rate thereof. For acetic acid, the reaction temperature is generally from 60°C to 85°C, desirably from 75°C to 85°C, and preferably from 78°C to 82°C. For formic acid, the reaction temperature is generally from 40°C to 60°C, preferably from 45°C to 55°C, and most preferably from 48°C to 52°C. Suitable reaction temperatures for other organic carboxylic acid reactants will range according to the stability of the intermediate peracid and their reactivity, i.e. the reasons set forth hereinabove. Inasmuch as the reaction is exothermic, it is generally necessary to cool the reaction after it has commenced to maintain the temperature within the above ranges. The reaction is generally conducted at atmospheric pressure, preferably under an inert atmosphere such as nitrogen.

30 Examples of only some of the different types of intermediate polybutene epoxides which are produced according to the present invention are set forth by the following reaction illustrations.

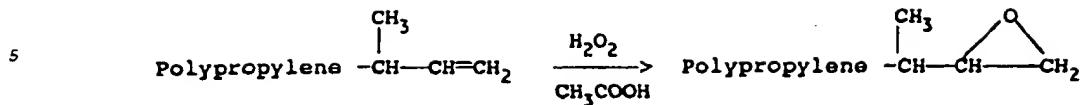


45 Due to the high reactivity of the type 3 epoxides shown above toward amination, these polybutene epoxide intermediates are preferred. Type 3 epoxides are produced starting with polybutenes containing high concentrations of type 3 starting polybutenes. An example of such a commercially available polybutene is Ultravis 30® (produced by British Petroleum). Examples of commercially available polybutenes having predominately the above type 1 end group structure include Hyvis® (which is a product by British Petroleum) and Parapol® (which is produced by Exxon).

Examples of some of the different types of intermediate polypropylene epoxides which are produced according to the present invention are set forth by the following reaction illustrations.

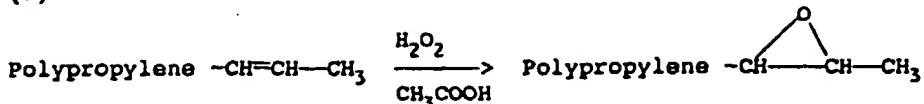


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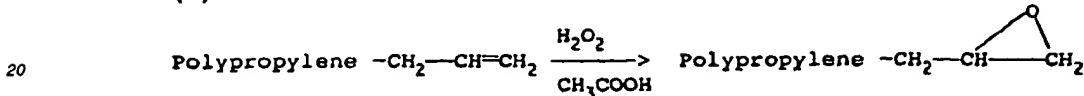
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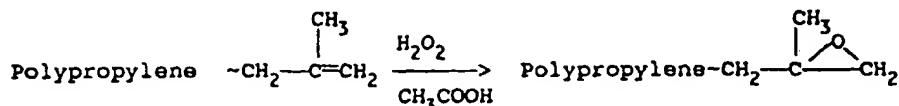
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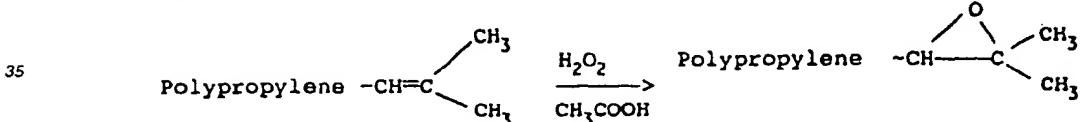
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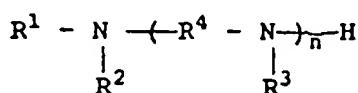
40 Due to the generally high reactivity of the above shown types 2 and 4 epoxides toward amination, these polypropylene epoxide intermediates are preferred. Types 2 and 4 epoxides are produced starting with polypropylenes containing high concentrations of the types 2 and 4 starting polypropylenes.

The degree of epoxidation is a function of the polyalkene end group structure and typically is at least 60, 70, or 75 percent.

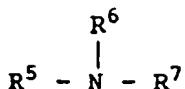
45 The epoxide reaction product is a viscous colorless to light yellow liquid which can be isolated by removal of the solvent by a variety of conventional techniques such as vacuum stripping, wiped film evaporation, and the like. The resulting intermediate product can be used without further purification in the subsequent amination step.

50 In a subsequent step of the process, the epoxy ring is opened by the amine compound to form the hydroxypoly-alkene amine product. The amine compound can be a primary amine or a secondary amine compound but not a tertiary amine compound and more specifically can be a monoamine, a diamine, or a polyamine (that is 3 or more amine groups). The amine compounds useful in preparing the hydroxypolyalkene amine compounds of the present invention, such as the various hydroxypolybutene amine compounds, are various monoamines, diamines, and polyamines such as cyclic diamines and polyamines, and alkylene diamines and polyamines of the formula

2



and cyclic monoamines and monoamines of the formula



wherein each of R¹, R², R³, R⁵, R⁶ and R⁷, independently, is a hydrogen atom or a hydrocarbyl radical containing from 1 to about 40 carbon atoms, provided however, that at least one of R⁵, R⁶ and R⁷, independently, is said hydrocarbyl, 10 at least one of R⁵, R⁶ and R⁷ is hydrogen, R⁴ is a divalent hydrocarbon radical containing from 1 to 18 carbon atoms and n is an integer from 1 to 10. Generally these hydrocarbyl radicals are aliphatic radicals free from acetylenic unsaturation and contain from 1 to about 10 carbon atoms. Examples of such various amine compounds include methylene polyamines, ethylene polyamines, butylene polyamines, propylene polyamines, pentylene polyamines, etc., cyclic polyamines such as piperazines and N-aminoalkyl substituted piperazines. Specific non-limiting representative examples of such polyamines also include ethylenediamine, diethylenetriamine, triethylenetetramine, tris-(2-aminoethyl)-amine, propylenediamine, trimethylenediamine, tripropylaminetetramine, tetraethylenepentamine, and heptaethylene-hexamine.

15 Among the monoamines useful in this invention are those of the formula HNR⁸R⁹ wherein R⁸ is an alkyl radical of up to 10 carbon atoms and R⁹ is hydrogen atom or an alkyl radical of up to 10 carbon atoms. Examples of suitable monoamines are ethylamine, diethylamine, n-butylamine, di-n-butylamine, allylamine, isobutylamine, cocoamine, stearylamine, laurylamine, and methyllaurylamine, oleylamine.

20 Cyclic monoamines are also useful in making the compositions of this invention. The cyclic ring can be substituted with hydrocarbyl radicals such as alkyl or alkenyl. In addition, the ring can also contain other nitrogen atoms including those not having hydrogen atoms bonded to them. Generally, these rings have 3-10, preferably 5 or 6 ring members. 25 Among such cyclic monoamines are aziridines, azetidines, azolidines, and piperidines.

Examples of preferred amine compounds include octylamine, nonylamine, decylamine, dodecylamine, ethylenediamine, propylenediamine, N,N-dimethylaminopropylamine, diethylenetriamine, and triethylene-tetramine, with ethylenediamine, N,N-dimethylaminopropylamine, and diethylenetriamine being preferred. Inasmuch as a compound high in basic nitrogen is desired, diamines and polyamines are preferred.

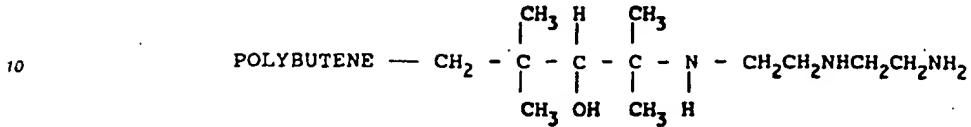
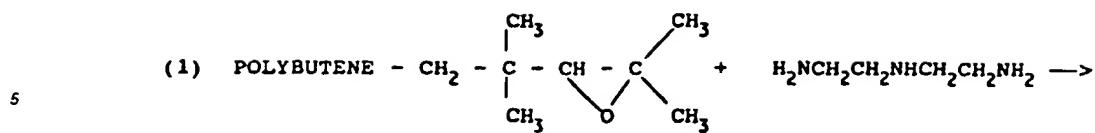
30 It is an important aspect of the present invention to utilize an excess of the amine compound in order to obtain homogeneity of the reaction mixture, and reasonable reaction rates, and minimize reaction of more than one epoxide intermediate with the same nitrogen. The amount of the excess amine is from 2 to 20 moles of amine per mole of epoxide, desirably from 4 to 16, preferably from 5 to 12, and more preferably from 8 to 12.

35 The use of a catalyst to increase rates in the reaction of the amine compounds is optional. Such catalysts are known to the art as well as to the literature. Examples of such catalyst include alumina, titanium dioxide, methane sulfonic acid, and paratoluene sulfonic acid. The amount of the catalyst is generally from 1 to 30, desirably from 4 to 20, and preferably from 5 to 10 weight percent based upon the total weight of the polyalkene epoxide.

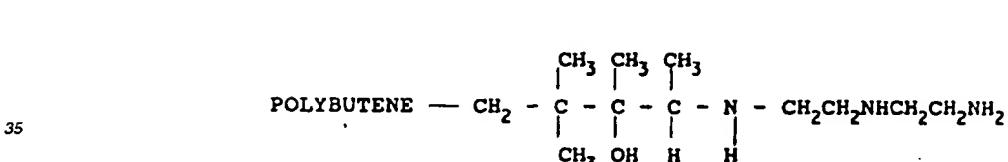
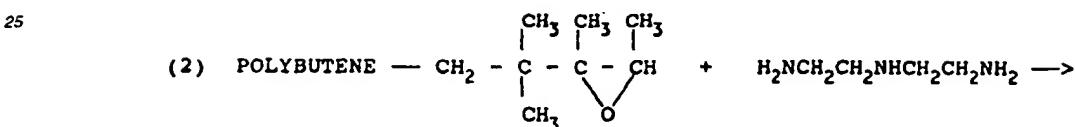
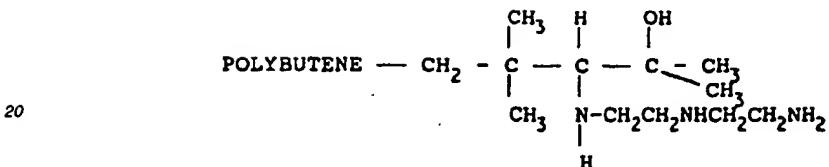
40 It is an important aspect of the present invention to utilize a high temperature during reaction of the amine but the temperature must be below the depolymerization temperature of the epoxidized polyalkene. Such reaction temperature is from 185°C to 290°C or 300°C, desirably from 230°C to 285°C, and preferably from 240°C to 280°C. The reaction is run in a closed vessel under moderate pressure such as up to about 2,1 MPa (300 psi) desirably from 0,07 to 0,5 MPa (10 to 70 psi), and preferably from 0,25 to 0,39 MPa (35 to 55 psi). Reaction pressure will be a function of the partial pressures of the individual reaction components at the reaction temperature. Conversions of epoxide to amine of at least about 10 or 15 percent, desirably at least 50 percent, and preferably at least 70 percent are generally achieved.

45 In the case of all reactive monoamines, diamines, and polyamines, at least one polyalkene epoxide molecule reacts with one amine molecule. In the case of diamines and polyamines containing more than one reactive amine group, the epoxide may react with any one of the reactive amine groups, producing a mixture of more than one type of a monohydroxypolyalkene amine. In the case of certain diamines, and polyamines, two polyalkene epoxide molecules 50 may react with the same amine molecule to give a mixture of monohydroxypolyalkene amine and dihydroxypolyalkene amine products.

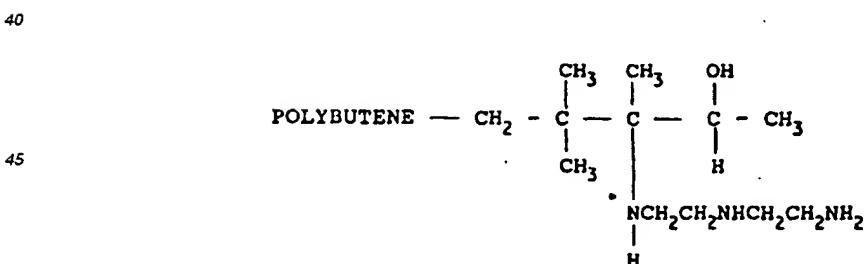
A general example of various monohydroxypolybutene amines obtained with the reaction of each of the general polybutene epoxide structural types set forth above with a polyamine, i.e., diethylenetriamine, is illustrated.



15 and/or

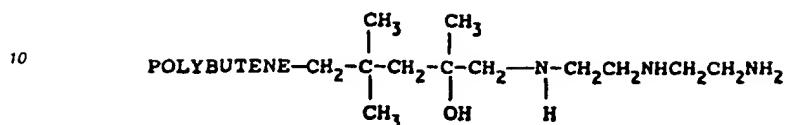
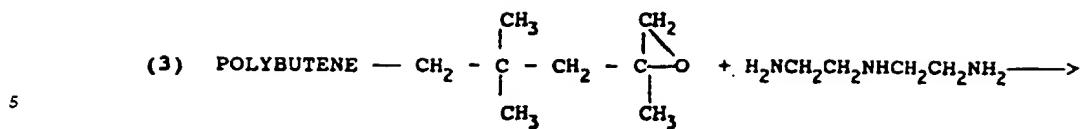


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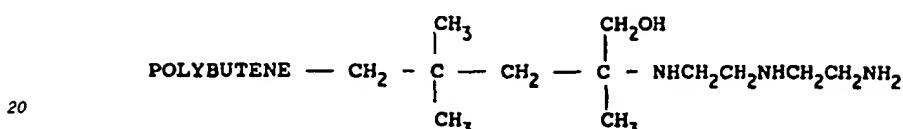


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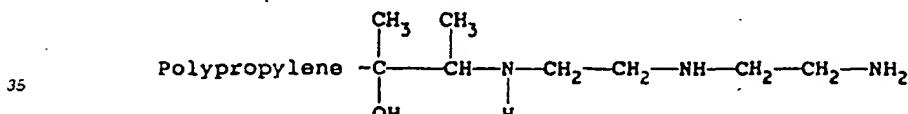
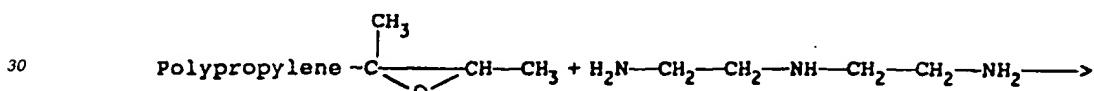
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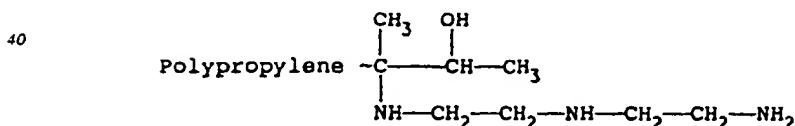
Examples of various monohydroxypolypropylene amines which are obtained from the reaction of each of the general polypropylene epoxide structural types set forth above with a polyamine, i.e., diethylenetriamine, is illustrated.

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(1)



and/or

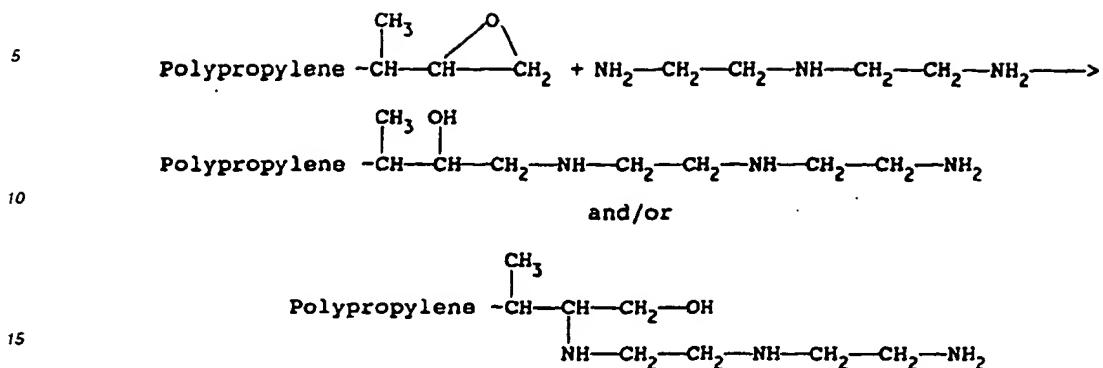


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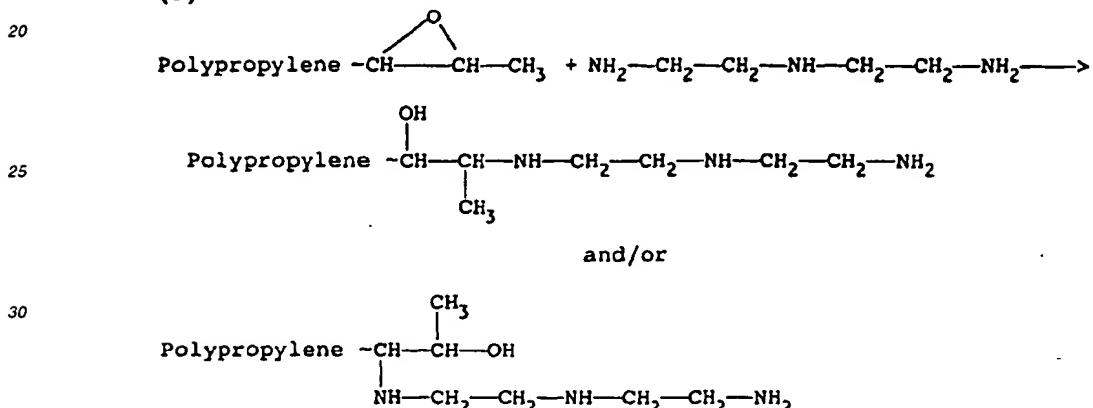
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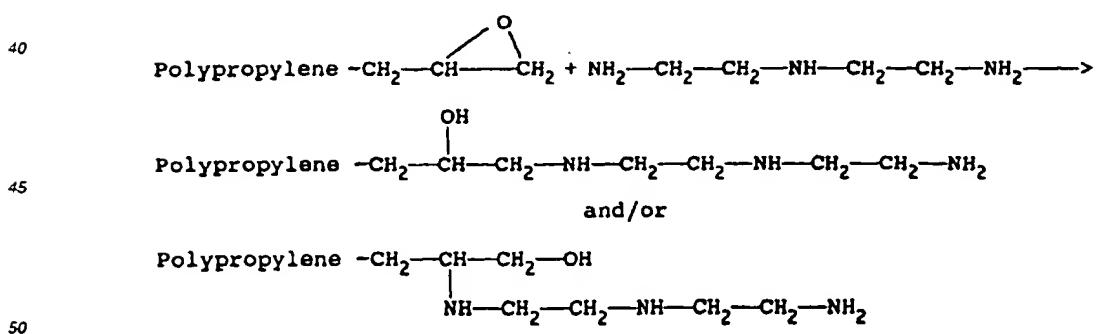
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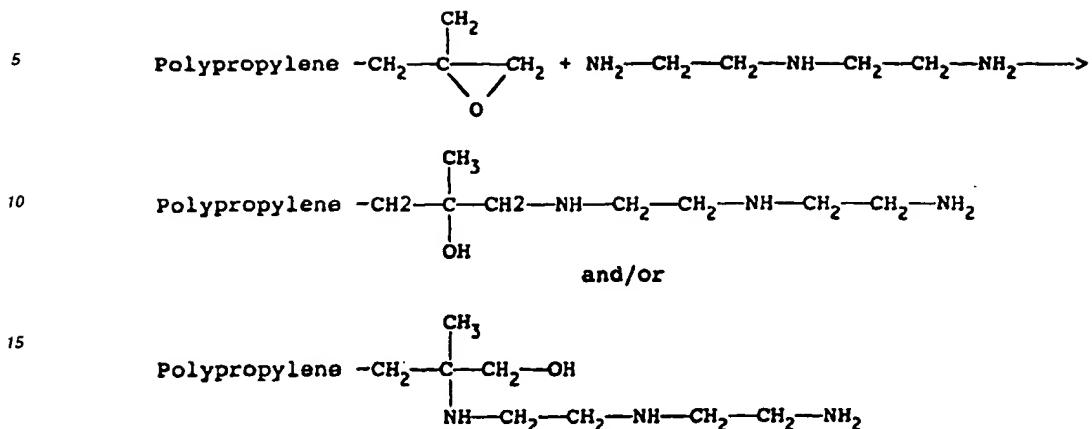
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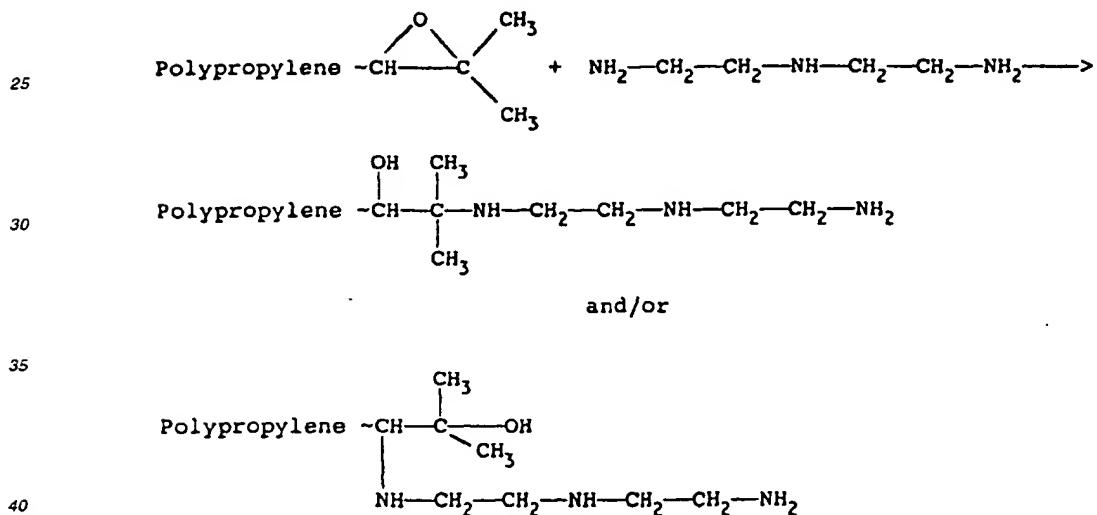


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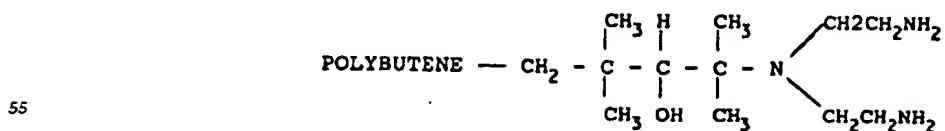
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45 As apparent from the above representative formulas, many different types of end structures result. Thus, it should be apparent that numerous different structures of monohydroxypolybutene amines can result when an epoxide polybutene intermediate is reacted with only one terminal amine group of a polyamine. It should be apparent to one skilled in the art that with regard to the utilization of an epoxide polypropylene intermediate that numerous different types of structures of various monohydroxypolypropylene amines will also result.

50 An example of an additional monohydroxypolybutene amine product which can be formed from type 1 polybutene epoxide is shown, as follows.

50



As apparent from the above structural formula, it should be apparent that various other types of monohydroxy-

polybutene amine products can be formed wherein the intermediate epoxy polybutene reacts with a non-terminal amine group. It is also possible that two or more polybutene epoxides can react with the same amine, but with the presence of a large excess of amine such reaction is minimized.

Inasmuch as free amines are generally detrimental to the use of a product of the present invention as a fuel additive, the excess amine is removed in any conventional manner such as by vacuum stripping, water washing, and the like. The amount of free amine contained in the halogen-free hydroxypolyalkene amine product solution is typically 0.2 percent by weight or less, and often 0.1 percent by weight or less. Once the excess amine compound has been removed from the hydroxy-polyalkene amine product, it is usually diluted with an aromatic or non-aromatic solvent so that it is more convenient to handle. An aromatic solvent is preferred. Examples of such solvents include xylene and C₉ aromatic solvent. The product dilution depends on the desired additive concentration required in the formulated fuel. Such additive concentration levels are well known to the art as well as to the literature.

The halogen such as chlorine content of the various hydroxypolyalkene amine compounds of the present invention is nil. That is, unless some residual halogen exists within the equipment utilized, the halogen content is nonexistent.

The dilute solution is added to the desired fuel. The fuel can be any conventional fuel, as well as any fuel known to the art and to the literature with specific examples including gasoline, diesel fuel, aviation fuel, and marine fuel. The amount of the hydroxypolyalkene amine composition is an effective amount to reduce the deposit of a particular fuel to a desirable level. The exact level will vary from fuel to fuel, and also with regard to the current state or country environmental standards as well as from month to month or year to year, as new control standards are enacted.

20 Inoperability of US-A- 3,794,586

Since US-A- 3,794,586 relates to a lubricating oil composition supposedly containing a hydroxylalkyl-substituted polyamine as an alleged product, various examples thereof were duplicated as follows to determine if the same could be produced.

25 Duplication of Example 3 of US-A- 3,794,586

Reaction of tetraethylenepentaamine with Hyvis 30 Epoxide.

In a 1 L flask equipped with a reflux condenser were placed 130.39 of Hyvis 30 Epoxide (with 1 percent oxygen as oxirane) and 19.12 g of tetraethylenepentaamine. The reactants were dissolved in 500 ml of toluene. The reaction solution was blanketed with nitrogen and heated to reflux at approximately 110°C. After 4 hours, the reaction was cooled to room temperature.

At this point, the procedure in US-A- 3,794,586 simply involved atmospheric distillation to remove the toluene solvent. This procedure would leave any unreacted amine dissolved in the reaction residue. Subsequent, possibly superficial, analytical characterization could lead to the conclusion that reaction had actually occurred.

In order to eliminate this possibility, a series of water and acid washes were used. The toluene solution was then washed with 500 ml of water and then with 250 ml of 10 percent hydrochloric acid. The washes were employed to extract out any unreacted amine left in the residue while leaving any reaction residue in the toluene. The solvent was then stripped from the organic layer to yield 128g of residue. This amount of residue corresponds to an essentially quantitative yield of unreacted starting material. A sample was submitted for percent basic nitrogen analysis. This revealed only 0.04 percent basic nitrogen. A sample of the residue was submitted for IR and NMR analysis. This sample was filtered to remove some salt-like material. The IR and NMR analysis of the precipitate indicated that these were salts of the starting amine, probably formed in the extraction washes. Neither NMR nor IR analyses revealed the presence of a hydrogen bonded to a nitrogen or any other evidence of amination.

45 Duplication of Example 4 of US-A- 3,794,586

Reaction of 1-(2-Aminoethyl)piperidine with Hyvis 30 Epoxide as per US-A- 3,794,586.

In a 1 L flask equipped with a reflux condenser were placed 130.5 g of Hyvis 30 Epoxide (with 1 percent oxygen as oxirane) and 13.8 g of 1-(2-aminoethyl)-piperidine. The reactants were dissolved in 500 ml of toluene. This reaction solution was blanketed with nitrogen and heated to reflux (113°C) for 4 hours.

As explained in the previous example, washing procedures were employed to remove residual, unreacted amine. The reaction was then cooled to room temperature, and the reaction was first washed with 200 ml of 10 percent hydrochloric acid and then with 200 ml of 10 percent potassium hydroxide solution. These washing procedures were used to insure that all of the unreacted amine was removed from the residue while leaving any reaction product in the toluene layer. The organic layer was then stripped of solvent. This reaction gave 129g of residue. This amount of residue is consistent with an essentially quantitative recovery of the starting Hyvis 30. A sample was submitted for percent basic nitrogen and gave 0.14 percent basic nitrogen. A sample submitted for IR and NMR analysis was filtered

to remove a precipitate. Analysis by IR and NMR of the precipitate indicated that this was a salt of 1-(2-aminoethyl) piperidine. The analysis of the residue showed no indication of any nitrogen or any evidence of amination.

As apparent from the above examples, the results presented in US-A- 3,794,586 could not be achieved. Instead of a hydroxypolyalkene amine being produced, only a residue was obtained which under evaluation using IR and NMR revealed no nitrogen to hydrogen bonding or other evidence of amination.

In contrast thereto, applicants' invention which does obtain high yields of an aminated product will be better understood by reference to the following examples which are representative of present invention.

Example 1

10

Epoxidation of Parapol 1300®

In a 5 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 1950 g of Parapol 1300, 975 g of heptane, and 27.0 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 1.05 g of 85 percent phosphoric acid, 0.75 g of 50 percent sulfuric acid, and 145.7 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added drop-wise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for 6 hours. The reaction was then quenched with 1000 ml of water. The organic layer was then washed two additional times with 1000 ml of water. The organic layer was then stripped of the heptane to yield 1974 g of the Parapol 1300 epoxide with 1.29 percent oxygen as oxirane (near 100 percent conversion).

Example 2

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Epoxidation of Hyvis 30®.

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In a 5 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 780 g of Hyvis 30, 390 g of heptane, and 14.8 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 0.42 g of 85 percent phosphoric acid, 0.3 g of 50 percent sulfuric acid, and 58.29 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added dropwise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for 6 hours. The reaction was then quenched with 400 ml of water. The organic layer was washed a further two times with 400 ml of water. The organic layer was then stripped of the heptane to yield 780.53 g of the Hyvis 30 epoxide with 0.98 percent oxygen as oxirane (81 percent conversion).

Example 3

35

Epoxidation of Ultravis 30®.

In a 5 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 1950 g of Ultravis 30, 975 g of heptane, and 27 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 1.05 g of 85 percent phosphoric acid, 0.75 g of 50 percent sulfuric acid, and 145.73 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added dropwise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for 6 hours. The reaction was then quenched with 1000 ml of water. The organic layer was washed a further two times with 1000 ml of water. The organic layer was then stripped of the heptane to yield 1769.5 g of the Ultravis 30 epoxide with 0.90 percent oxygen as oxirane (74 percent conversion).

45

Example 4

Epoxidation of Parapol 950®.

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In a 5 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 780 g of Parapol 950, 390 g of heptane, and 14.8 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 0.57 g of 85 percent phosphoric acid, 0.41 g of 50 percent sulfuric acid, and 79.9 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added drop-wise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for 6 hours. The reaction was then quenched with 400 ml of water. The organic layer was washed a further two times with 400 ml of water. The organic layer was then stripped of the heptane to yield 779.83 g of the Parapol 950 epoxide with 1.39 percent oxygen as oxirane (84 percent conversion).

Example 5Amination of Parapol 950® Epoxide (Ex. 4) with Dimethylaminopropylamine.

5 To a 1 L Parr bomb equipped with a mechanical stirrer were added 105 g of Parapol 950 epoxide (1.39 percent oxirane oxygen), 105 g of dimethylaminopropylamine, and 10.5 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C 0,91 MPa (130 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 150 ml of chloroform and washed twice with 450 ml of water. The 10 organic layer was stripped of solvent to yield 95 g of product with a percent basic nitrogen of 0.89 percent (40 percent conversion of available epoxide).

Example 6Amination of Ultravis 30® Epoxide (Ex. 3) with Dimethylaminopropylamine.

15 To a 1 L parr bomb equipped with a mechanical stirrer were added 97.9 g of Ultravis 30 epoxide (0.9 percent oxirane oxygen), 97.8 g of dimethylaminopropylamine, and 9.7 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C 0,91 MPa (130 psi) while stirring. This temperature was maintained for 18 hours. The 20 reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 150 ml of chloroform and washed three times with 500 ml of water. The organic layer was stripped of solvent to yield 83 g of product with a percent basic nitrogen of 1.13 percent (75 percent conversion of available epoxide).

Example 7Amination of Parapol 950® Epoxide (Ex. 4) with Diethylenetriamine.

25 To a 1 L Parr bomb with a mechanical stirrer were added 102.8 g of Parapol 950 epoxide (1.39 percent oxirane oxygen), 102.9 g of diethylenetriamine, and 10.2 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0,28 MPa (40 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 150 ml of chloroform and washed twice with 200 ml of water. The 30 organic layer was stripped of solvent to yield 99.1 g of product with a percent basic nitrogen of 2.06 percent (61 percent conversion of available epoxide).

Example 8Amination of Ultravis 30® Epoxide (Ex. 3) with Diethylenetriamine.

40 To a 2 L Parr bomb equipped with a mechanical stirrer were added 657.9 g of Ultravis 30 epoxide (0.9 percent oxirane oxygen), 621.0 g of diethylenetriamine, and 63.0 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0,28 MPa (40 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. 45 The reaction product was dissolved in 500 ml of toluene and washed twice with 500 ml of water. The organic layer was stripped of solvent to yield 640 g of product with a percent basic nitrogen of 1.83 percent (81 percent conversion of available epoxide).

Example 9Amination of Parapol 1300® Epoxide (Ex. 1) with Diethylenetriamine.

50 To a 1 L Parr bomb equipped with a mechanical stirrer were added 223 g of Parapol 1300 epoxide (1.29 percent oxirane oxygen), 621.0g of diethylenetriamine and 21.9 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0,28 MPa (40 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 300 ml of chloroform and washed twice with 400 ml of water. The organic layer was stripped of solvent to yield 215 g of product with a percent basic nitrogen of 1.65 percent (56 percent conversion

of available epoxide).

Example 10

5 Amination of Hyvis 30® Epoxide (Ex. 2) with Diethylenetriamine.

To a 1 L Parr bomb equipped with a mechanical stirrer were added 143.7 g of Hyvis 30 epoxide (0.98 percent oxirane oxygen), 67.1 g of diethylenetriamine, and 10 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0.28 MPa (40 psi) while stirring. This temperature was maintained for 18 hours. 10 The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 250 ml of chloroform and washed twice with 250 ml of water. The organic layer was stripped of solvent to yield 215 g of product with a percent basic nitrogen of 1.30 percent (53 percent conversion of available epoxide).

15 Example 11

Amination of Ultravis 30® Epoxide (Ex. 3) with Ethylenediamine.

To a 1 L Parr bomb equipped with a mechanical stirrer were added 100 g of Ultravis 30 epoxide (0.9 percent oxirane oxygen), 58.3 g of ethylenediamine, and 10.0 g of alumina. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/1.41 MPa (200 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature, and the reaction mixture was separated from the alumina catalyst. The reaction product was dissolved in 200 ml of chloroform and washed three times with 500 ml of water. The organic layer was stripped of solvent to yield 83.8 g of product with a percent basic nitrogen of 1.13 percent (56 percent conversion of available epoxide).

Example 12

Amination of Ultravis 30® Epoxide (Ex. 3) with Diethylenetriamine without Catalyst.

30 To a 1 L Parr bomb equipped with a mechanical stirrer were added 72.0 g of Ultravis 30 epoxide (1.1 percent oxirane oxygen) and 73.0 g of diethylenetriamine. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0.25 MPa (35 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature. The reaction product was dissolved in 150 ml of chloroform and washed twice with 200 ml of water. The organic layer was stripped of solvent to yield 70.0 g of product with a percent basic nitrogen of 2.16 percent (79 percent conversion of available epoxide.)

Example 13

40 A 1136 l (300 gallon) stainless steel reactor was charged with 179.8 kg (396 lbs.) of Parapol® 1300. The polybutene was heated to 80°C and 2.5 kg (5.5 lbs.) of glacial acetic acid and 198 lbs. of heptane were added. A mixture of 0.1 kg (0.21 lbs.) of 85 percent phosphoric acid and 0.07 kg (0.15 lbs.) of 50 percent sulfuric acid was prepared. This acid mixture and 13.4 kg (29.6 lbs.) of 70 percent hydrogen peroxide were added simultaneously to the stirred reaction mixture over a period of one hour while maintaining the temperature between 79-84°C. After the addition was completed, the reaction was stirred for an additional six hours while the temperature was maintained at 80°C. At the end of this time, the agitation was stopped, and the lower aqueous layer was dropped. The product layer was washed, by adding 274.4 kg (600 lbs.) of deionized water and agitating the mixture at 60°C for 15 minutes. The agitation was then stopped, and the lower layer was dropped. The product was then washed again with an additional 274.4 kg (600 lbs.) of deionized water. The product solution was heated to 110°C, and the heptane was distilled off. As the distillation slowed, 66.04 cm (26 inches) of vacuum was applied to the reactor, and the temperature was increased to 140°C to strip the last of the solvent off of the product. The stripped product was then dropped to a stainless steel drum and weighed. This reaction gave 179.3 kg (395 lbs.) of polybutene epoxide with 1.03 percent oxygen as oxirane (98 percent yield).

55 Example 14

A 189 l (50 gallon) reactor was charged with 59 kg (130 lbs.) of Parapol® 1300 epoxide (Example 13) and 55.7 kg (122.7 lbs.) of diethylenetriamine. The reactor was purged with nitrogen and then sealed. The reaction mixture was

heated to 220°C which gave a pressure of 0,11 MPa (15 psi). The reaction mixture was stirred at this temperature for 18 hours. Afterwards, the reaction was then cooled to 65°C, and the agitator was stopped. After 30 minutes the lower diethylenetriamine layer was dropped. The upper product layer was dissolved in 29,5 kg (65 lbs.) of xylene. The xylene solution was washed by charging the reactor with 59,0 kg (130 lbs.) of water. This wash mixture was heated to 60°C, and stirred for 15 minutes. The agitation was then stopped, and the lower aqueous layer was dropped. A second water wash was performed with another 59,0 kg (130 lbs.) of water. The organic layer was then stripped of xylene to yield a product having 1.51 percent basic nitrogen (57.5 percent conversion of the available epoxide). The amount of halogen or chlorine within the Examples was nondetectable.

10 Example 15

A 1136 l (300 gallon) stainless steel reactor charged with 165,3 kg (364.1 lbs.) of Ultravis 30® polybutene was heated to 80°C, and 2,3 kg (5.1 lbs.) of glacial acetic acid was added. The reaction mixture was diluted by adding 84,9 kg (187 lbs.) of xylene. A mixture of 0,16 kg (0.35 lbs.) of 85 percent phosphoric acid and 0,11 kg (0.25 lbs.) of 50 percent sulfuric acid was prepared. This mixture and 12,4 kg (27.3 lbs.) of 70 percent hydrogen peroxide were added to the stirred reaction mixture over a period of one hour while maintaining the temperature at about 80°C. After the addition was completed, the reaction was stirred for an additional six hours while maintaining the temperature at 80°C. After the reaction was complete, the agitation was stopped, and the lower aqueous layer was dropped. The product layer was washed by adding 257,9 kg (568 lbs.) of deionized water and agitating the mixture at 60°C for 15 minutes. The agitation was then stopped, and the lower layer was dropped. The product was then washed again with an additional 257,9 kg (568 lbs.) of deionized water. The product solution was heated to 110°C, and the xylene was distilled off. As the distillation slowed, 66 cm (26 inches) of vacuum was applied to the reactor, and the temperature was increased to 140°C to strip the last of the solvent off the product. The stripped product was then dropped to a stainless steel drum and weighed. This reaction gave 163,4 kg (360 lbs.) of polybutene epoxide with 1.07 percent oxygen as oxirane (97.8 percent yield, 88 percent conversion.)

25 Example 16

A 1891 (50 gallon) reactor was charged with 59,0 kg (130 lbs.) of Ultravis 30 epoxide (Example 15) and 27,2 kg (60 lbs.) of diethylenetriamine. The reactor was purged with nitrogen and then sealed. The reaction mixture was heated to 220°C which gave a pressure of 0,11 MPa (15 psi). The reaction mixture was stirred at this temperature for 18 hours. Afterwards the reaction was then cooled to 65°C, and the agitator was stopped. After 30 minutes the lower diethylenetriamine layer was dropped. The upper product layer was dissolved in 29,5 kg (65 lbs.) of xylene. The xylene solution was washed by charging the reactor with 59,0 kg (130 lbs.) of water. This wash mixture was heated to 60°C, and stirred for 15 minutes. The agitation was then stopped, and the lower aqueous layer was dropped. A second water wash was performed with another 59,0 kg (130 lbs.) of water. The organic layer was then stripped of xylene to yield a product having 1.89 percent basic nitrogen (70.5 percent conversion of the available epoxide).

30 Example 17

In a 1 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 300 g of Amoco Polypropylene 9013 (Mn=685), 150 g of toluene, and 6.1 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 0.81 g of 85 percent phosphoric acid, 0.58 g of 50 percent sulfuric acid, and 36 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added dropwise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for six hours. The reaction was then quenched with 250 ml of water. The organic layer was then washed two additional times with 250 ml of water. The organic layer was then stripped of the toluene to yield 303.7 g of the Polypropylene 9013 epoxide with 1.09 percent oxygen as oxirane (61 percent conversion).

40 Example 18

In a 1 L flask equipped with a mechanical stirrer, a reflux condenser, and an addition funnel were placed 300 g of Amoco Polypropylene 9012 (Mn=740), 150 g of toluene, and 7.3 g of glacial acetic acid. This solution was heated to 80°C. A mixture of 0.89 g of 85 percent phosphoric acid, 0.64 g of 50 percent sulfuric acid, and 39.4 g of 70 percent hydrogen peroxide was placed in the addition funnel. The peroxide solution was added dropwise to the reaction mixture over a period of one hour. After the addition, the reaction was stirred at 80°C for six hours. The reaction was then quenched with 250 ml of water. The organic layer was then washed two additional times with 250 ml of water. The organic layer was then stripped of the toluene to yield 312.1 g of the Polypropylene 9012 epoxide with 1.95 percent

oxygen as oxirane (91.9 percent conversion).

Example 19

5 To a 1 L Parr bomb equipped with a mechanical stirrer were added 96.7 g of Polypropylene 9013 epoxide (with 1.09 percent oxygen as oxirane) and 100 g of diethylenetriamine. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/0,25 MPa (35 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature. The reaction product was dissolved in 300 ml of toluene and washed twice with 250 ml of water. The organic layer was stripped of solvent to yield 80.0 g of product with a percent basic nitrogen of 1.06 percent (38 percent conversion of available oxirane).

Example 20

15 To a 1 L Parr bomb equipped with a mechanical stirrer were added 106 g of Polypropylene 9013 epoxide (with 1.09 percent oxygen as oxirane) and 100 g of dimethylaminopropylamine. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/1,1 MPa (150 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature. The reaction product was dissolved in 300 ml of toluene and washed twice with 250 ml of water. The organic layer was stripped of solvent to yield 101.7 g of product with a percent basic nitrogen of 0.5 percent (26.7 percent conversion of available oxirane).

20 Example 21

To a 1 L Parr bomb equipped with a mechanical stirrer were added 114 g. of Polypropylene 9012 epoxide (with 1.95 percent oxygen as oxirane) and 105.8 g of triethylenetetramine. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature. The reaction product was dissolved in 300 ml of toluene and washed twice with 250 ml of water. The organic layer was stripped of solvent to yield 112.3 g of product with a percent basic nitrogen of 2.25 percent (35.1 percent conversion of available oxirane).

30 Example 22

To a 1 L Parr bomb equipped with a mechanical stirrer were added 99.6 g of Polypropylene 9012 epoxide (with 1.95 percent oxygen as oxirane) and 96.7 g of ethylenediamine. The vessel was closed and purged with nitrogen. The reaction was heated to 245°C/1,55 MPa (220 psi) while stirring. This temperature was maintained for 18 hours. The reaction was then cooled to room temperature. The reaction product was dissolved in 300 ml of toluene and washed twice with 250 ml of water. The organic layer was stripped of solvent to yield 97.2 g of product with a percent basic nitrogen of 1.35 percent (40.8 percent conversion of available oxirane).

40 Generally, hydroxypolypropylene amines and hydroxypolybutene amines having high amounts of basic nitrogen content therein such as at least above 0.4, 0.8, or 1.0 percent, often above 1.3 or 1.5 percent, and even above 1.8 or 2.0 percent can readily be achieved up to a value of about 4 percent, 6 percent, 8 percent, and even 9 or 10 percent by weight. As apparent from the above examples, high yields of hydroxypolybutene amines were obtained.

Claims

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1. A process for preparing a halogen-free hydroxy-polyalkene amine composition by first reacting a polybutene having an average molecular weight of from 400 to 2200 or a polypropylene having a number average molecular weight of from 170 to 2200 with hydrogen peroxide in the presence of an organic carboxylic acid and an acid catalyst and then reacting the obtained epoxidized polybutene or epoxidized polypropylene at a temperature of from 185 to 300°C in a closed vessel at a pressure of up to about 2.1 MPa (300 psi) with an excess of from 2 to 20 moles per mole of said epoxidized polybutene or epoxidized polypropylene of at least one type of an amine compound being a primary or secondary monoamine, a primary or secondary diamine or a primary or secondary polyamine.
2. The process according to claim 1, wherein the molecular weight of said polybutene is from 700 to 1600 and wherein the molecular weight of said polypropylene is from 290 to 1900.
3. The process according to claim 1 or 2, wherein said reaction temperature is from 230°C to 285°C.

4. The process according to any of claims 1 to 3, wherein said amine compound is dimethylaminopropylamine, diethylenetriamine or ethylenediamine, or combinations thereof.

5. The process according to any of claims 1 to 4, wherein at least 15 percent of said epoxidized polyalkene are converted.

Patentansprüche

10 1. Verfahren zur Herstellung einer halogenfreien Hydroxypolyalkenamin-Zusammensetzung durch zunächst Umsetzung eines Polybutens mit einem mittleren Molekulargewicht von 400 bis 2200 oder eines Polypropylens mit einem zahlenmittleren Molekulargewicht von 170 bis 2200 mit Wasserstoffperoxid in Gegenwart einer organischen Carbonsäure und eines sauren Katalysators und anschließende Umsetzung des erhaltenen epoxidierten Polybutens oder epoxidierten Polypropylens bei einer Temperatur von 185 bis 300°C in einem geschlossenen Kessel bei einem Druck von bis zu etwa 2,1 MPa (300 psi) mit einem Überschuß von 2 bis 20 Mol pro Mol des epoxidierten Polybutens oder des epoxidierten Polypropylens mit mindestens einem Typ einer Aminverbindung, die ein primäres oder sekundäres Monoamin, ein primäres oder sekundäres Diamin oder ein primäres oder sekundäres Polyamin ist.

20 2. Verfahren nach Anspruch 1, wobei das Molekulargewicht des Polybutens 700 bis 1600 beträgt und wobei das Molekulargewicht des Polypropylens 290 bis 1900 beträgt.

3. Verfahren nach Anspruch 1 oder 2, wobei die Reaktionstemperatur von 230°C bis 285°C beträgt.

25 4. Verfahren nach einem der Ansprüche 1 bis 3, wobei die Aminverbindung Dimethylaminopropylamin, Diethylenetriamin oder Ethylenediamin oder Kombinationen davon ist.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei mindestens 15 % des epoxidierten Polyalkens umgesetzt werden.

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Revendications

35 1. Un procédé de préparation d'une composition d'amine d'hydroxypolyalcène exempté d'halogène en faisant réagir d'abord un polybutène ayant un poids moléculaire moyen en nombre compris entre 170 et 2200 avec du peroxyde d'hydrogène en présence d'un acide carboxylique organique et d'un catalyseur acide et en faisant réagir ensuite le polybutène époxydé ou polypropylène époxydé ainsi obtenu à une température comprise entre 185 et 300°C dans un récipient fermé sous une pression d'au maximum environ 2,1 MPa avec un excès de 2 à 20 moles, par mole du polybutène époxydé ou polypropylène époxydé, d'au moins un type d'une amine qui est une monoamine primaire ou secondaire, une diamine primaire ou secondaire ou une polyamine primaire ou secondaire.

40 2. Le procédé selon la revendication 1, dans lequel le poids moléculaire du polybutène est compris entre 700 et 1600 et le poids moléculaire du polypropylène est compris entre 290 et 1900.

45 3. Le procédé selon la revendication 1 ou 2, dans lequel la température de réaction est comprise entre 230°C et 285°C.

4. Le procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'amine est la diméthylaminopropylamine, la diéthylénetriamine ou l'éthylénediamine ou une combinaison de ces composés.

50 5. Le procédé selon l'une quelconque des revendications 1 à 4, dans lequel une proportion d'au moins 15 pour cent du polyalcène époxydé est transformée.

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